NC Division of Public Health (DPH) Opinion Paper on "Source Tracking" of PCBs in Badin Lake to the Alcoa/Badin Facility PCB Releases

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What are "PCBs" and "Aroclors"? -

- Polychlorinated biphenyls ("**PCBs**") are a group of synthetic organic compounds that were manufactured in the U.S. between 1930 and 1977.
- Commercial mixtures of PCBs manufactured in the U.S. by Monsanto went by the trade name "**Aroclors**".
- The manufacture of PCBs in the U.S. was banned in 1977 because of their persistence in the environment and evidence of potential adverse effects. Prior to their ban, the disposal of PCBs and PCB-containing equipment was not subject to federal regulation. In 2000 the US Environmental Protection Agency (EPA) estimated that prior to regulation approximately 1.25 billion pounds of PCBs were purchased by U.S. industry, 750 million pounds (60 percent) were still in use in capacitors and transformers, 55 million pounds (4 percent) had been destroyed by incineration or degraded in the environment, and over 450 million pounds (36 percent) were either in landfills or dumps, or were available to biota via air, water, soil, and sediments.
- There are no known natural sources of PCBs.
- PCBs were never intended to be released directly into the environment; most uses were in closed industrial systems. Important properties of PCBs for industrial applications include thermal stability, fire and oxidation resistance, and solubility in organic compounds. PCBs were used as insulating fluids in electrical transformers and capacitors, as plasticizers, as lubricants, as fluids in vacuum pumps and compressors, and as heat transfer and hydraulic fluids.
- The group of chemicals referred to as "**PCBs**" are 209 chemically related chlorinated organic compounds ("**congeners**"). Their chemical structure consists of a biphenyl molecule backbone with 1 to 10 chlorine atoms attached at 10 possible locations on the biphenyl molecule. The number and location of the chlorine atoms on the biphenyl backbone influences the chemical and toxicological properties, as well as the environmental fate, of each PCB congener.
- There were approximately 12 different **Aroclor** commercial mixtures that were marketed in the US, each consisting of a different mixture of some of the 209 congeners. The congener make-up of the individual Aroclors also varied over the time.

PCBs in the Environment -

- The number and location of chlorine atoms on a PCB congener imparts each congener's unique chemical, environmental, biological and toxicological properties.
- Generally, as the number of chlorine atoms increases the toxicity increases, there is an increased tendency for the congener to increase in concentration as it is passed up the food chain, and its persistence in the environment increases.
- When PCBs are released into the environment different congeners in the mixtures will move about differently due to differences in their chemical properties. Over time, and as the congeners from a particular release move differently through the environment, the

appearance and the proportions and concentrations of the congeners in the mix is changed (a process termed “weathering”).

- As the PCB mixture moves through the environment the make-up of the congener mix changes with each movement from one compartment (air, soil, water, sediment, biota) to the next. The more compartments a release moves through, and the longer the time period since the initial release, the greater the alteration.
- The chemical and physical make-up of soils, sediments or waters, and biota that PCB mixtures come into contact with, will all impact the movement of individual congeners.
- Microorganisms are able to partially breakdown some PCBs with 4 or fewer chlorine atoms.
- PCBs with fewer chlorines are generally more water soluble, more volatile, and less toxic. PCBs with higher numbers of chlorines are more fat soluble and have a stronger tendency to attach strongly to soils, sediment, and living organisms. Organisms are less able to metabolize (breakdown) or eliminate the higher chlorinated PCB congeners. This can result in their increasing concentrations in organisms higher on the food chain that eat PCB-contaminated food sources.
- The uptake of PCBs by fish will vary by species and size within a lake. Uptake characteristics are impacted by the characteristics of the particular food chain and may vary for a species in different lakes or in different areas of a large lake.

The History of PCB Analysis -

Historically, PCBs analysis of environmental samples has used **Aroclor “fingerprinting”**. This method was relatively inexpensive and did not require highly specialized analytical instruments. The analysis involves matching the pattern derived from gas chromatography (GC) to the analyst’s best guess of the original Aroclor(s) released into the environment. The quantity of PCBs in the sample is based on this tentative identification.

The limitations of this Aroclor identification and quantitation method include:

- Limited sensitivity to detect low concentrations of Aroclors
- Aroclor identification and quantitation are impacted by the age of the release due to environmental “weathering” of the mixture
- A release of multiple Aroclors increases the potential bias in identification and quantitation by complicating pattern matching.

An improved analytical method for PCB identification and quantitation was developed by EPA in the late 1990’s (Method 1668A for **congener-specific PCB analysis**). This method is able to identify and quantify each of the 209 PCB congeners. The advantages of this method are:

- The method does not rely on pattern matching (“fingerprinting”) to the original Aroclor
- The identification and quantitation of individual congeners is not biased by weathering
- The method is much more analytically sensitive than the Aroclor method, providing detection limits in the range of 1000 times or more lower than the Aroclor method

Limitations of the congener-specific method:

- It requires highly specialized, expensive analytical instrumentation (high resolution gas chromatograph & high resolution mass spectrometer, HRGC/HRMS)
- It requires a highly trained operator

- The analysis is expensive, approximately $1000 per sample compared to $150 per sample for Aroclor analysis (Investigations are underway by EPA and others to develop modified congener-specific methods that are less expensive, yet provide the enhanced identification and quantitation of M1668A)

Environmental studies have shown that total PCBs in fish tissue quantified with the congener-specific method (M1668a) typically results in 2 to 5 times greater concentrations of total PCBs than quantified with the Aroclor method (in the same tissue samples).

DPH's Opinion on Source Tracking the PCBs Identified in Badin Lake Fish -

It is the opinion of DPH that there is not adequate information to directly associate the PCBs found in the fish of Badin Lake, or found in blood samples of persons consuming fish from Badin Lake, to identify the Alcoa/Badin facility as the ONLY possible source.

It is important to note that the EPA and DENR have come to the same conclusion that the fish tissue data cannot be linked solely to the Alcoa/Badin facility.

Reasoning-

- **There is nothing unique about the PCBs found in the Badin Lake fish to link them to the Alcoa/Badin facility as the only source.** To directly link PCBs in fish or humans to a particular source requires some unique aspect of the PCBs found in both. The PCBs that have been identified associated with the Alcoa/Badin facility are those generally found throughout NC and the US. In documents reviewed by DPH, as well as in documents supplied by NC DENR/Division of Waste Management summarizing PCBs found in soils on the Alcoa/Badin facility, there is nothing unique about these PCBs.
- **Other inputs of PCBs into Badin Lake have not been ruled out or characterized.** PCBs are ubiquitous in the environment. They are transported locally, regionally, and globally in the atmosphere. They fall to earth by dry deposition and in precipitation onto distant soils, and into distant surface waters and sediments. It is possible that PCBs in Badin Lake have been contributed from sources other than the Alcoa facility. As far as the DPH knows, upstream sources of PCBs have not been evaluated.
- **The ability to link the PCBs in the fish only to Alcoa/Badin is unlikely.** Because of the age of the PCB releases on the Alcoa/Badin facility, it is not likely that a future link can be made that the PCBs in the fish are due ONLY to releases from the Alcoa/Badin facility. This does not mean that future technologies may be capable of making this association. However, at this time DPH is not aware of any such technology in development.
- **The available information does not support that the PCBs found in a person can only be linked to PCBs identified in Badin Lake fish or on the Alcoa/Badin facility.** People that have never eaten fish from Badin Lake will accumulate PCBs in their body from other sources. People may be exposed to PCBs from other types of food items (dairy, meats, and commercially caught fish). Other sources of exposure to PCBs include old electrical devices and appliances. These releases may be significant following accidental spills or fires. As discussed above, there is nothing unique about the PCBs that have been indentified in Badin Lake relative to PCBs used commonly throughout NC and the US, and ultimately those that have been widely distributed in the environment.

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